FlightLinux

A New Option for Spacecraft
Onboard Computer Operating Systems
that enables IP-in-space

Goddard Space Flight Center
Code 586 – Science Data Systems

Agenda

- Project Description
- The Linux Operating System
- Porting Linux to Onboard Computers
- Proof of Concept Approach
- Benefits
- Related Research

FlightLinux Project

- Selected by NASA HQ/OES/AIST in May 2000 as a funded project.
- Government-Industry team:
  - GSFC Code 586, Science Data Processing
  - GSFC Code 582, Flight Software
  - QSS Group, Inc.
- Principal Investigator: Pat Stakem, QSS Group, Inc.

Why Linux?

- Open source
  - Flexible
  - Extendable
  - Free
- Multiple target platforms
- Supports networking which enables multiprocessing
- Commonality with ground platforms - easy to migrate applications
- Real-time extensions
- Large experience base to draw on

FlightLinux onboard computer Port Assessment

Target	base architecture	assessment
RAD6000	R/6000 - PPC	cots
RH32	MIPS, R3000	cots
Mongoose-V	MIPS, no MMU	cots, modified
RHPPC	PPC	cots
RAD750	PPC-750	cots
ERC32	SPARC	cots
IA-32	Pentium, 80x86	cots
SNAP-1	StrongARM	cots

here, cots = a Linux version exists.

FlightLinux Port
Device drivers

- 1553 - new mapping of the SOIF Reference model to this and other Master/Slave architectures.
- 1773
- IEEE-1394 (FireWire)/SpaceWire
- CAN - Controller Area Network
- 10-BaseT, 100 BaseT

Benefits

- Onboard LAN
- Onboard file system, in the bulk memory
- Onboard Java applets, via JVM
- Onboard web page serving
- IP to and on the spacecraft

Potential Benefits
The OES Sensor Web

- FlightLinux Enables the OES Sensor Web
  - Internet connectivity with constellations of Earth orbiting satellites
  - Commonality of ground and space-based environments for ease of application migration

Related Research

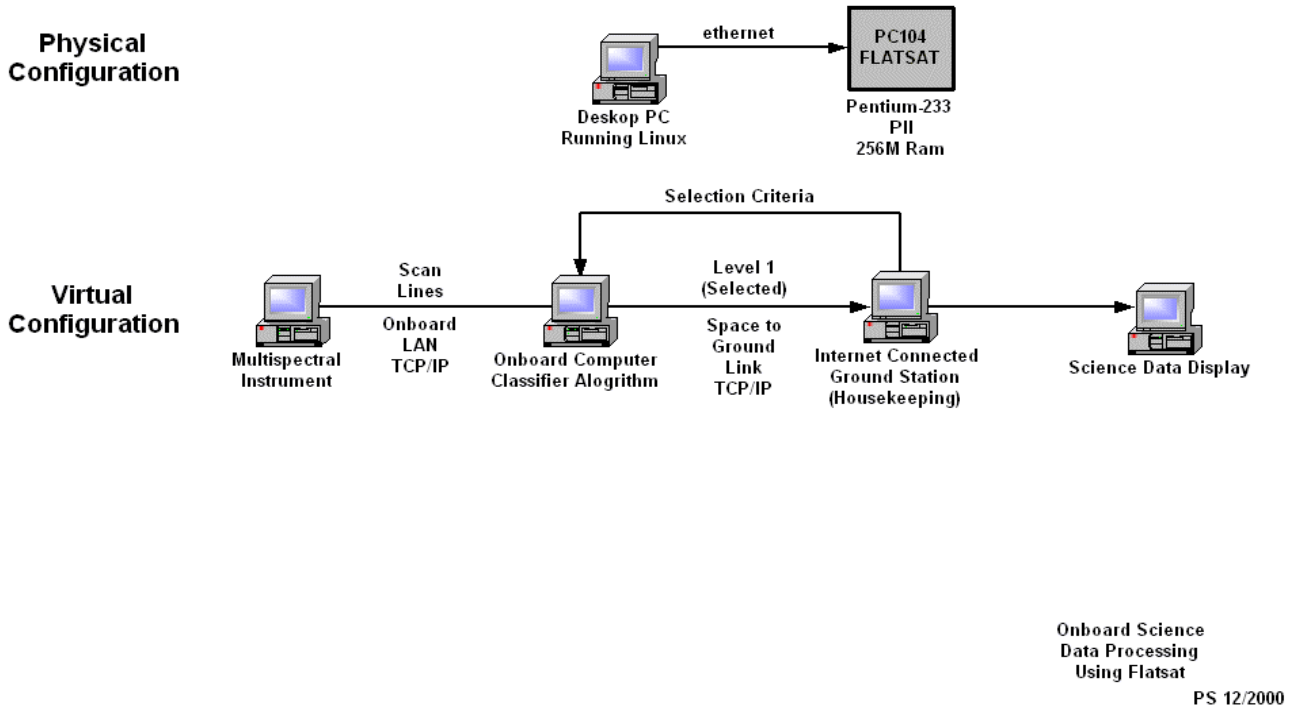
- Posix-compliant flight software
  - (GSFC code 582 ongoing research)
- End-to-end IP; IP-to-the-spacecraft
  - IP tunneling via CCSDS
  - IP over 1553
- Java-onboard
- Onboard networked file systems
- Beowulf - distributed processing

Related Research
The OMNI Experience

- IP-to-the-Spacecraft
  - Demonstrated May/June 2000
- UoSat-12 spacecraft,
  - 80386EX onboard computer, 4 megabytes
  - pSOS operating system, with TCP/IP stack
- Demonstrated functionality
  - Ping
  - Ftp up & down

Related research-onboard algorithms

- FlatSat (Omni Project)
  - 233 MHz Intel-based processor
  - embedded system, PC-104 bus, Linux
- Multispectral image classification algorithm
  - implemented in Java, 7 Megabyte footprint
  - 70-90% data reduction (demonstrated 1/2001)
- Onboard LAN connected instrument
  - TCP/IP over 10Base-T
  - simulated scanning instrument, Landsat MSS-class
- Downlink
  - TCP/IP over 10Base-T


Physical Configuration
ethernet
PC104 FLATSAT
Deskop PC Running Linux
Pentium-233 PII 256M Ram
Virtual Configuration
Selection Criteria
Scan Lines
Onboard LAN TCP/IP
Level 1 (Selected)
Space to Ground Link TCP/IP
Multispectral Instrument
Onboard Computer Classifier Alogrithm
Internet Connected Ground Station (Housekeeping)
Science Data Display
Onboard Science Data Processing Using Flatsat
PS 12/2000

Related research - flying FlightLinux

- UoSat-12
  - Memorandum of understanding in work
  - Flight proof of concept
  - Continuation of OMNI work

FlightLinux
Project Web Page

- http://aqua.qssmeds.com/flightlinux/